

ELIMINATION OF OVERHANG IN LINER/BARRIER/SEED LAYERS USING POST-DEPOSITION SPUTTER ETCH

FIELD OF THE INVENTION

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The invention is generally related to the field of fabricating liners/barriers in contacts, vias, and copper interconnects in semiconductor devices and more specifically to the elimination of overhang in liner/barrier/seed deposition using sputter etch.

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BACKGROUND OF THE INVENTION

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As the density of semiconductor devices increases, the demands on interconnect layers for connecting the semiconductor devices to each other also increases. Therefore, there is a desire to switch from the traditional aluminum metal interconnects to copper interconnects. Unfortunately, suitable copper etches for a semiconductor fabrication environment are not readily available. To overcome the copper etch problem, damascene processes have been developed.

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In a conventional interconnect process, the aluminum (and any liner/barrier metals) are deposited, patterned, and etched to form the interconnect lines. Then, an interlevel dielectric (ILD) is deposited and planarized. In a damascene process, the ILD is formed first. The ILD is then patterned and etched. A thin liner/barrier material is then deposited over the structure followed by copper deposition over the liner/barrier material. Then, the copper and liner/barrier material are chemically-mechanically polished to remove the material from over the ILD, leaving metal interconnect lines. A metal etch is thereby avoided.

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The most practical technique for forming copper interconnects is electrochemical deposition (ECD). In this process, after the liner/barrier material is

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deposited, a seed layer of copper is deposited. Then, ECD is used to deposit copper over the seed layer. Unfortunately, physical vapor deposition (PVD) processes typically used to deposit the liner/barrier and seed materials have poor step coverage. This is due to the fact that PVD processes use a line of sight technique. As a result, an overhang 18 of liner/barrier 14 and/or seed 16 material occurs at the top of a trench or via 12 as illustrated in FIG. 1. The overhang causes a severe problem during the subsequent copper ECD. Specifically, a seam occurs in the copper fill material.

This problem also occurs in forming contacts. For contacts, after the liner/barrier material is deposited, the contacts are typically filled with tungsten. An overhang in the liner/barrier material contributes to seam formation in the tungsten contact.

One proposed solution for overcoming the above problem uses a pre-sputter etch after the trench and via or contact etch, but before liner/barrier deposition. Unfortunately, this can result in high interfacial resistance due to the oxide (from the walls of the trench/via/contact) redepositing on the inside surface and bottom of the trench/via/contact. Furthermore, the contact/via profiles are not preserved which can cause resistance variation and leakage problems.

Another solution is to use a thinner liner/barrier or seed layer. Unfortunately this affects the reliability and increases the interfacial resistance due to insufficient coverage on the sidewalls and bottom of the trench/via/contact.

Another solution involves the use of CVD (chemical vapor deposition) of a titanium liner/barrier and the copper seed layer. CVD offers significantly better step coverage. Unfortunately, CVD Ti typically requires high temperature, which negatively impacts the backend thermal budget. Current CVD Cu processes have problems with layer adhesion and rough morphology.

SUMMARY OF THE INVENTION

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The invention is a post-deposition sputter etch. After depositing a PVD film, a sputter etch is performed to remove the overhang of material at the top of a trench, via, or contact. The PVD film may be a liner/barrier layer and/or a seed layer. The trench/via/contact is then filled with the appropriate material.

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An advantage of the invention is providing an improved fill process using a PVD liner/barrier and sputter etch that eliminates the formation of seams in the fill material.

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This and other advantages will be apparent to those of ordinary skill in the art having reference to the specification in conjunction with the drawings.